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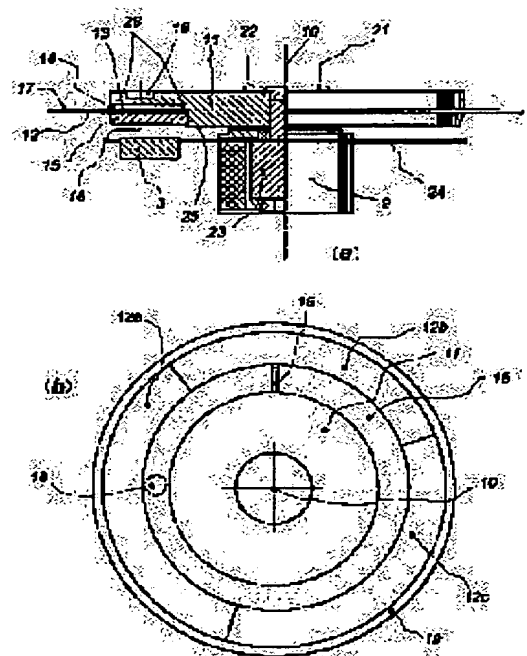
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(54) COLOR WHEEL AND IMAGE FORMING DEVICE PROVIDED WITH THE COLOR WHEEL

(57)Abstract:

PROBLEM TO BE SOLVED: To attain reproducing high optical properties and mechanical properties by preventing an annular light transmissive area from being interrupted by a supporting element and sticking a filter segment to a supporting body in a flat state in a sticking zone which is positioned opposite to a rotary axis and not arranging a through-hole part on the filter segment.

SOLUTION: The filter segment 12 is fixed to the supporting body 11 through an adhesive layer 13 so as to form a step on the surface of the supporting body 11. The filter segment 12 is accurately brought into contact with the supporting body 11 in a radial direction 25 and the axial direction 26 by the step part in the supporting body edge part area. The surface adhesion is performed only in an area constituted of a slender annular zone facing opposite to the center of rotation, then, most of the filter segment surface remains as a light transmissive annular effective zone facing outwards in the case of viewing from the rotary axis in the radial direction. Then, the installation of such an additional holding element requiring a through-hole part like a hole as filter segment is avoided.



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CLAIMS

[Claim(s)]

[Claim 1] It is the color wheel (1) equipped with the disk-like base material (11). A base material is pivotable focusing on a medial-axis line (10), and the flat filter segment (12) is attached in the periphery part of a base material. This filter segment is turned to radial to axis of rotation (10). In the thing of a format which the circular ring-like field is formed in the periphery part of a base material in radial, and the field of the shape of this circular ring is arranged in the said alignment to the medial-axis line, and has light transmission nature It is formed so that the field of circular ring-like light transmission nature may not be interrupted depending on a base material element like a maintenance web. The color wheel which the filter segment (12) has pasted the base material (11) in the shape of a field in the strip adhesion zone (13) turned to the opposite side with axis of rotation, and is characterized by the filter segment (12) not having the penetration section.

[Claim 2] The color wheel according to claim 1 by which the adhesion zone (13) is flatly arranged in the shape of a circular ring in same axle to axis of rotation (10) at the periphery part of a base material (11).

[Claim 3] The color wheel according to claim 1 or 2 whose adhesives are epoxy system adhesives.

[Claim 4] The color wheel given [to claims 1-3] in any 1 term currently formed as a stopper of radial [for an adhesion zone being sunk by the base material (11) and positioning a filter segment (12)], and the direction of an axis.

[Claim 5] The color wheel given [to claims 1-4] in any 1 term by which the retaining ring (15) is arranged as an auxiliary means with a group at the side which deserted with the glue line of a filter segment.

[Claim 6] The color wheel given [to claims 1-5] in any 1 term in which at least two filter segments (12) are prepared.

[Claim 7] The color wheel given [to claims 1-6] in any 1 term to which balancing of the color wheel (1) is carried out in symmetry of revolution.

[Claim 8] The color wheel according to claim 7 to which the base material ingredient removal section for balancing (18) is eccentrically formed in the base material (11), and this base material ingredient removal section has not penetrated the disk-like base material (11) in any locations.

[Claim 9] The color wheel given [to claims 1-8] in any 1 term which the filter segment (12) consists of the glass plate, and this glass plate is covered with the interference filter, has temperature stability by within the limits whose filter shape of this interference filter is 10 degrees C - 100 degrees C, and has humidity stability within the limits of whenever [phase antiaircraft air humidity / 0% - 90% of].

[Claim 10] A color wheel given [to claims 1-9 to which the dimension of a color wheel (1) and the dimension of the adhesion equipment of a filter segment (12) make possible bigger centrifugal acceleration than 300g] in any 1 term.

[Claim 11] The color wheel given [to claims 1-10] in any 1 term which has the means (21) for a base material (11) to fix to a driving shaft (22) right in the middle, or is manufactured in one with the driving shaft (22).

[Claim 12] The image generator which an image generating device (7) and projection optics (8) are established, and is characterized by the thing which the image generating device (7) equipped with switching time smaller than 10msec, and which it switches and is consisted of the matrix of the optical control element of a formula in the image generator which has the color wheel (1) driven by the motor the light source (5) and given [to claims 1-11] in any 1 term.

[Claim 13] The image generator according to claim 12 with which the image generating device (7) is formed based on reflection.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention is the color wheel equipped with the disk-like base material. A base material Focusing on the medial-axis line, it is pivotable and the flat filter segment is attached in the periphery part of a base material. This filter segment is turned to radial to axis of rotation, the circular ring-like field is formed in the periphery part of a base material in radial, the field of the shape of this circular ring is arranged in the said alignment to the medial-axis line, and it is related with the thing of a format which has light transmission nature.

[0002] Furthermore, this invention relates to the image generator which has the light source and the color wheel driven by the motor of the above-mentioned format.

[0003]

[Description of the Prior Art] The equipment of the format stated at the beginning is used for the location which must generate a periodic color change one after another, for example in optical system like a new image generator or a display unit. In order to make such a periodic color change produce, a color filter is revolved in an optical path one after another. For this reason, the so-called color wheel (Farbrad) is used. This color wheel is formed in the shape of a disk, and has the filter segment arranged circularly at that periphery part. These filter segments form one ring and it is rotated focusing on the medial-axis line of a wheel. A filter segment is revolved by turns in an optical path by rotation of a color wheel. Thereby, a desired periodic color change is made to arise (JI EDOU alto Rhine foundation / Texas install face company, digital micro mirror device (The Eduard Rhein Foundation/Texas Instruments Inc., Digital Micromirror Device DMD)). By imposing a high demand to the image quality of an image generator, change of a color must be performed very quickly. That is, a filter segment must be made to exercise through a light beam at high speed. In this case, the big object for laborious works based on centripetal acceleration occurs for a color wheel, especially the filter segment of high sensitivity. It may be a value until this centripetal acceleration has that it is hundreds times as large as gravitational-acceleration g and it exceeds 1000g in good image quality especially. Furthermore, in order to obtain a high working hour to suitability of equipment, this equipment must fill the very high demand of this cardiac rotation. The very high demand of the brightness on condition of the high power light source is also imposed on still such an image generator. According to the light source of such high power, equipment is suitably exposed to the high temperature load to 100 degrees C. A very high demand is imposed on the holding power and color stability of a filter segment from the above-mentioned reason. Furthermore, use of the color wheel in the so-called display of low cost can be broadly used, only when a color wheel can be manufactured very economically to a high quality demand.

[0004] The color wheel equipped with the filter segment by which it has been circularly arranged for the use in an image generator is indicated by the Europe patent application public presentation No. 615156 specification. The filter segment is being fixed to the glass ring in such equipment. The fault of such equipment is that a glass ring is expensive. Furthermore, when this cardiac rotation is required highly, realizing this demand takes time and effort extremely. Furthermore, additional optical loss arises with a glass ring. This will reduce the economical efficiency of the whole equipment. Furthermore, the color wheel equipment which has a fixed element like a spoke between each segment is well-known. These spokes reduce the whole light transmission value of color filtering too, and limit economical efficiency.

[0005]

[Problem(s) to be Solved by the Invention] The technical problem of this invention is offering the equipment which removed the fault of the conventional technique. As for especially a color wheel, it is desirable to be able to cover long operation time, and to be able to have a high optical property and a high mechanical characteristic refreshable, and for it to be able to manufacture economically moreover.

[0006]

[Means for Solving the Problem] In order to solve this technical problem, the field of circular ring-like light transmission nature is formed so that it may not be interrupted depending on a base material element like a maintenance web, the filter segment has pasted the base material in the shape of a field in the strip adhesion zone turned to the opposite side with axis of rotation, and it was made for the filter segment not to have the penetration section with the configuration of this invention.

[0007]

[Effect of the Invention] A flat filter segment is fixed to the periphery part of the base material of a disk form by adhesion, and the field of annular light transmission nature is not optically interrupted between each filter segment in a hand of cut depending on the ingredient of nontransparent nature. The filter segment is pasted up on the base material in the shape of a field in the strip zone it turned [zone] to the opposite side with axis of rotation. Since adhesion of the shape of this field is performed only in the field which consists of the long and slender annular zone suitable for the opposite side, most filter segment sides regard it as the center of rotation from axis of rotation to radial, and it is left behind as an annular effective zone of light transmission nature toward an outside. For example, an additional maintenance element which needs the penetration section like a hole in a filter segment is completely avoidable. That is, a stress zone is made to be generated by the edge field when a hole is prepared in a filter segment. Such a stress zone has a possibility of causing the problem of fracture, when the mechanical force is required highly, as a result it cannot be permitted.

[0008] The disk-like base material has the means for fixing a driving shaft right in the middle, for example, a hole. This driving shaft is driven by the motor and rotates a color wheel at the high rotational frequency to several 1000 revolutions per minute. In an image generator, in order to acquire good image quality, a high rotational speed which the centrifugal acceleration exceeding 300g generates is required. However, in very high image quality, the centrifugal acceleration of 800g-2000g within the limits is needed. A dimension setup of the color wheel equipped with the suitable adhesion zone must be especially performed carefully by this. While the noise does not occur slightly and high useful life longevity is moreover acquired, in order to attain this good cardiac rotation (Gleichlauf), balancing must be very correctly possible for a color wheel. At the time of suitable use, it is advantageous that the operation time MTBF exceeding 40000 hours carries out for obtaining. For this reason, required balancing quality must fulfill the specification G6.3 of ISO (1940-1973). These values must be attained where a color wheel is assembled. That is, it must be constituted so that balancing with the easy structure of a color wheel may be possible in exit status with a group. It becomes possible to remove an ingredient from a disk-like base material in the form of at least one notch of an ingredient advantageously in the completed color wheel by the configuration of this invention in the case of a balancing process. In this case, if such a notch is formed as a hole, it is advantageous. Such a notch or a hole is formed as foramen cecum ossis forntalis in a base material disk, and penetrates a base material. However, these notches may already be prepared before a balancing process. Subsequently to these notches for balancing, a packing material is given suitably. In this case, especially adhesives are suitable. As an ingredient for a base material disk, plastics can be considered like a metal. However, especially especially a light metal, for example, aluminum, or an aluminium alloy is suitable. As a driving gear for a color wheel, an electric motor and a drive motor which is especially used for a hard disk are used.

[0009] An interference layer filter is used as a color filter. In the well-known format, such an interference layer filter consists of mutual layers which consist of $\text{TiO}_2/\text{SiO}_2$. A dimension setup of these layers is carried out according to the filter shape demanded. Since a temperature change and the optical high stability over air humidity are required, a thick layer must be obtained. Such a layer can be advantageously attained by the so-called sputtering forming-membranes method.

[0010] In the usual case, at least two different segments are needed for a color wheel. however, it is alike occasionally, it carries out and 3 color system is used. In this 3 color system, color filtering consists of the filter segment each other arranged for example, formed from red and a green and blue color forward and backward. The color wheel especially suitable for the color sensitivity of an image generator consists of the arrangement

which has four filter segments. In this case, the segment which counters mutually has the same color, for example, red, and two another segments have a different color, for example, blue, and green. The filter shape of a filter segment must have stability to temperature and humidity extremely. There must be the whole stability of a filter shape within the limits of a gap of less than 5nm in the humidity requirement of the inside of a 10 degrees C - 100 degrees C temperature requirement, and whenever [phase antiaircraft air humidity / 0% - 90% of] advantageously. However, for the use in an image generator, especially if the filter has only the gap of less than 1nm in the range specified in this way, it is advantageous. Thus, good filter quality can be economically acquired by said cathode-sputtering method like especially magnetron sputtering. however, especially the economical sputtering method is indicated by the U.S. Pat. No. 5295417 specification -- as -- intra -- it is the approach which is well-known based on the concept in the mode (Intramode). Main components are indicated with the reactant chopper sputtering method (Chopperzerstaebungsverfahren) by the well-known magnetron by this specification for example, based on the Europe patent No. 564789 specification. In the chopper sputtering method, the source of magnetron sputtering is made to exercise by timing controlling expression, or it is superimposed on the additional electrical potential difference of magnetron discharge by which timing control was carried out in several 100Hz- / several 100kHz frequency range. In this case, since a spatter is carried out while a metallic target has reactant gas added, a substrate deposits in a suitable dielectric layer. To a change of timing control or a chopper ring, coupling of an inside frequency or superposition is also possible. Thereby, an economical deposit of the dielectric layer [as / in the approach of timing controlling expression] by magnetron sputtering is possible.

[0011] In order to paste up a filter segment and a base material disk good especially, a notch may be prepared in the adhesion zone of a base material disk. This notch corresponds to an adhesion side and can hold adhesives in a same axle circle zone suitably. As for the depth of such a notch, it is desirable that it is equivalent to the optimal adhesion thickness. Such optimal adhesion thickness is in 50-200 micrometers for proper adhesives especially. the high demand to proper adhesives sake -- epoxy system adhesives -- the epoxy system adhesives of the type DP 460 of a three em company (3M) are used advantageously. A notch can be formed so that a ridge or a spacer may be formed in the bore and outer diameter of a notch. These spacers form an exact back face in the rotation flat surface for a filter segment. Joggling of the back face equipped with the annular notch is carried out to a disk-like support surface, and a filter segment is arranged almost in the said alignment to the disk cross section on the cross section. The radial shoulder of a crevice can be constituted so that it may serve also as the stopper shoulder radial [for positioning of this shoulder of a filter segment]. By such configuration, attachment of the filter segment before adhesion becomes remarkably easy. Namely, what is necessary is just to merely compare each filter segment of each other in the same height, to make a base material disk contact shaft orientations and radial, to position, and to fix by hardening of adhesives subsequently. For example, if the retaining ring which consists of plastics like a polymer is stuck to a filter segment by pressure in the field of a base material crevice, such an attachment process will become still easier. Thereby, location immobilization of the filter segment is carried out in an adhesion zone. Thereby, by small components mark, this whole equipment can be attached very simply and correctly, and balancing of it can be continuously carried out correctly as mentioned above according to the structure by this invention in which balancing is possible. By this, manufacture of components with a much more big permission dimension error is attained. This supports economical manufacture.

[0012] In order to enable the monitor of the location of the color wheel equipped with the proper color filter continuously, a multiplier mark (Zeitindexmarke) must be attached in a color wheel at marking which consists of plastics advantageously like a polyamide, or the time. Such marking or a time index mark can be attached in a base material disk easily [the above-mentioned retaining ring]. This retaining ring serves also as an anchoring auxiliary means. If the color wheel by this invention is used for the image generator equipped with the light source which has light which is turned subsequently to an image generating device through the filter segment of the rotating color wheel by which motorised was carried out, it is advantageous. This image generating device consists of the matrix of the optical control element of controlling expression or a switch type. Thereby, formation of an image is performed in an image screen through projection optics. In order to acquire good image quality, the switching time of less than 10 msec is required because of such an optical control element. For the image generating device, the equipment which consists of the small mirror of controllable a large number, i.e., the equipment based on reflection, is especially suitable. In this case,

advantageously, if the image generating device based on reflection of "a digital mirror device (Digital Mirror Device)" is used, it is advantageous. By the color wheel by this invention using the high change-over rate of the above-mentioned image generating device, an image generator can be manufactured economically. This image generator makes possible the big display dimension equipped with high luminous intensity with high quality.

[0013]

[Embodiment of the Invention] Next, the gestalt of the operation which showed this invention to the drawing is explained.

[0014] The rough general drawing of the display of the new format equipped with predetermined equipment is shown in drawing 1. The color wheel 1 combined with the motor 2 and the location report machine 3 formed in the base material 24 is formed. This color wheel 1 has the base material 11 with which the filter segment 12 was fixed. The light source is shown by the sign 5. From this light source, the light beam 6 which has an optical axis 60 injects. A light beam 6 penetrates the filter segment 12, and collides with the image generating device 7. The image you were made to produce by this image generating device is projected by the image screen 9 according to projection optics 8. A motor 2 rotates a color wheel 1 focusing on axis of rotation 10. Thereby, the variation rate of the filter segment 12 is carried out into a light beam 6 by turns. Each location of the filter segment 12 is detectable through the location report machine 3. The image corresponding to the color of an image generating device 7 smell lever is made to arise according to the color of the filter segments 12a-12c located in a light beam 6. Therefore, the rotational frequency of a color wheel is equivalent to image repeat frequency, and is number of per minute 1000 rotation. Centripetal force works to a filter segment by such rotation. This centripetal force has that it is larger than 1000 times of terrestrial gravitation.

[0015] By asking for high un-fading nature (Farbechtheit), the demand to the filter shape of the filter segment 12 is very complicated. The magnitude of the image screen 9 is very large. When bright in a perimeter, in order to attain contrast big enough, the lamp of high power with which suitably high heat dissipation is performed is used for the light source 5. There is a possibility that the temperature of a maximum of 100 degrees C may arise to the field of this equipment by this. The temperature load to the filter segment 12 becomes high still more with the radiant heat of the light source 5. In order to accept such a load and the demand to very high color stability over all the useful life longevity of a product, the filter segment has the filter layer 17. If these filter layers are constituted as a stable dielectric layer which does not have column-like structure, they are advantageous. It also has temperature stability not only having thermal resistance but very high long lasting [such a layer]. The gap which is not desirable as for the spectrum curve within the limits of 10 degrees C - 100 degrees C is only less than 1nm. Still such a layer has the adhesion force which was conspicuous in the fundus (Untergrund). Such adhesion force is very important when using adhesives for a layer.

[0016] Drawing 2 shows the example of the equipment by this invention. The fragmentary sectional view of this equipment is shown in drawing 2 (a), and the top view of equipment is shown in drawing 2 (b). In Rota 23 established in the motor 2, operation association of the base material 11 is carried out by the supporting structure 21 through the shaft-like bond part material 22 in Rota 23. To the front face of this base material, joggling of the filter segment 12 is carried out to a base material 11 by the glue line 13, and it is being fixed to it. The joggling section in a base material edge field is formed so that radial [25] and shaft orientations 26 may be made to contact a base material correctly and a filter segment can be positioned to them. The thickness of a glue line 13 is prescribed by the spacer 14. This spacer 14 may be the crevice prepared on the surface of the base material in the field of for example, an adhesion part. The adhesion part is covered by the retaining ring 15. This retaining ring 15 is used for coincidence also as support for the location marking 16 for location report machine 3. It **** to the allowable error of the structure of a color wheel, and **** in the fixed condition of the base material 11 in Rota 23, and imbalance arises in equipment. Such imbalance is compensated by balancing equipment 18. This balancing equipment 18 is a crevice like a hole advantageously established, for example in the base material. When the base material 11 consists of aluminum or an aluminium alloy, it is common that a hole 18 is attached in the rim section field of a base material 11 for balancing. Such a hole usually has the diameter of 5-10mm in a depth of a maximum of 3mm. In an image generator, the advantageous diameter of the whole color wheel is within the limits of 75-130mm. In this example, the diameter of the whole color wheel is 108mm, and the diameter of a base material is 81mm. If the width of face of an adhesion ring zone is within the limits of 3-10mm, it is advantageous. Since the bond part of Rota 23 and a base material 11 has very big effect to balancing of equipment, balancing of the equipment with which the base material 11 was attached to Rota 23

is performed. In order to suppress imbalance in a limit, the base material is constituted as a component of Rota 23. Especially manufacture is economical if a base material 11, Rota 23, or the bond part material 22 is formed from one part by this. If the filter segment 12 is attached to a base material 11 as a result this and the one-bond part material 22, and Rota 23 in this case by the side which deserted with the motor, it is advantageous.

[0017] On the occasion of the use on which a so critical demand is not imposed, the filter segment 12 can be held with the elastic ingredient fastened between the retaining ring 15 and the filter segment 12. Furthermore, the protect ring 19 may be arranged as an additional protective device at the rim section of the filter segment 12.

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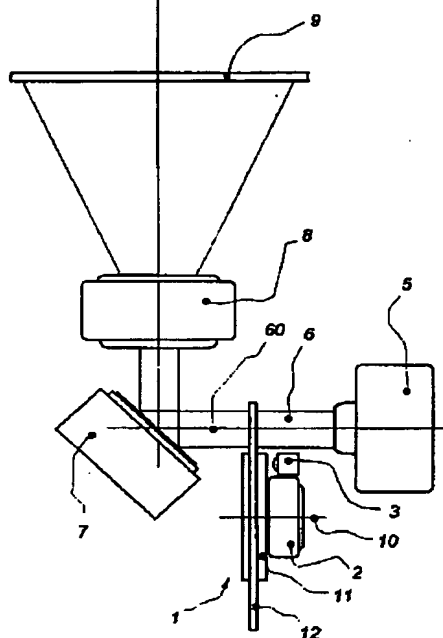
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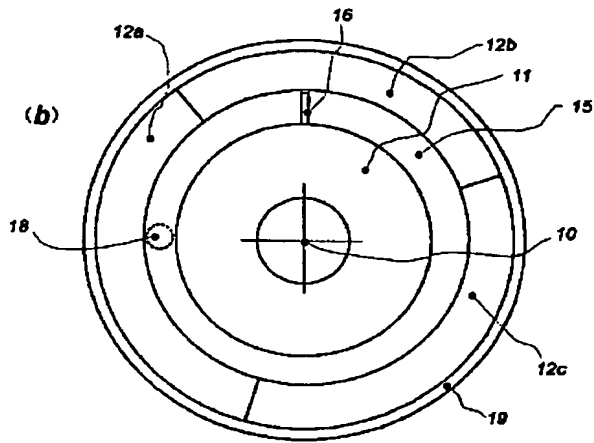
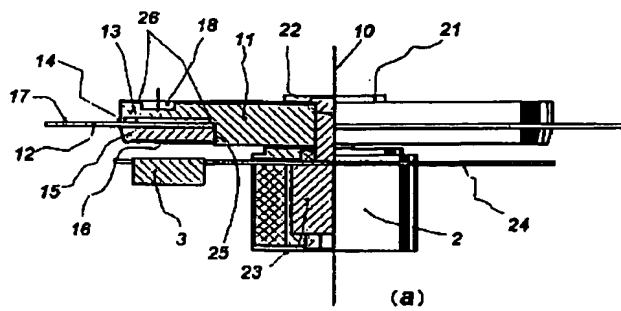
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DRAWINGS

[Drawing 1]



[Drawing 2]



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